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ABSTRACT

The objectives of this study were: (1) to compare retention rates between self-paced (SP) and classical lecture (CL) chemistry students as measured by the proportion of students who received a withdrawal or unofficial withdrawal grade; (2) as indicated by the distribution of final grades, to compare student achievement between SP and CL students; and (3) to conduct a follow-up study as to what happens to Chemistry 2 students after they complete or withdraw from the course. To carry out the study objectives, grade reports and current enrollment status records were obtained for all students who had enrolled in an SP or CL Chemistry 2 course during the Spring and Fall 1971. Results of the study showed that: (1) the withdrawal rate was significantly greater with the SP approach than with the CL approach; (2) significantly more CL students attained successful achievement; (3) the proportion of students earning the highest grades was higher for the SP group; (4) a significantly higher proportion of CL Chemistry 2 students enrolled in General Chemistry; (5) a greater proportion of SP students passed General Chemistry; (6) a greater proportion of SP students attained successful achievement in General Chemistry; (7) a significantly greater proportion of SP Chemistry 2 withdrawals re-enrolled in Chemistry 2; and (8) the "net withdrawal rate" for the SP students was significantly greater. An appendix provides a table of 11 SP re-enrollees who passed Chemistry 2 the second enrollment. (DB)

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An Evaluation of A Self-Paced Approach To Elementary Chemistry Instruction

Office of
Institutional Research
Cerritos College
Summer, 1973

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Research Director

JC 730 193

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An Evaluation of A Self-Paced Approach To Elementary Chemistry Instruction

INTRODUCTION

The "Self-Paced" ("S.P.") approach to the teaching of Elementary Chemistry (Chemistry 2) was developed in an attempt to provide students with a learning environment that would be more conducive to semi-independent study relative to traditional lecture approaches. Working at their own pace and through the use of behavioral objectives the students must attain predetermined levels of mastery for each section of the course before going on to the next section.

At the request of the chairman of the Sciences, Engineering and Math division, the Office of Institutional Research was asked to conduct a study of the self-paced approach to teaching Chemistry 2. The general purpose of this investigation was to evaluate the effects this approach to Chemistry instruction has had upon the students enrolled in the program. Final course grades, operationally defined as measures of achievement, and course retention-rates for both Chemistry 2 and General Chemistry (Chemistry 1.1) were selected as criterion variables in an attempt to provide objective measures of course effectiveness. Furthermore, in order to provide bench marks for comparison analogous data from "classical lecture" ("C.L.") Chemistry 2 courses was obtained.

The specific objectives of the study were to: (1) compare retention rates between "S.P." and "C.L." Chemistry students as measured by the proportion of students who received a W (Withdrawal) or UW (Unofficial Withdrawal) grade; (2) as indicated by the distribution of final grades,

compare student "Achievement" between "S.P." and "C.L." students; and (3) conduct a follow-up study as to what happens to Chemistry 2 students after they complete or withdraw from the course, particularly their academic achievement in Chemistry 1.1.

In order to carry out the aforementioned objectives of the study, grade reports, and current enrollment status records were obtained for all students who had enrolled in an "S.P." or "C.L." Chemistry 2 course during the Spring and Fall, 1971.

Enrollment and Retention

Self-Paced Classes

In the Spring Semester, 1971, a total of 53 students were enrolled in both a Chemistry 2 "S.P." lecture and laboratory. Of these 53 students 31 or 58.5% received a "Withdrawal" (W)* grade.

Concerning the Fall Semester, 1971, a total of 80 students were enrolled in both a Chemistry 2 "S.P." lecture and laboratory.

Combining the Spring, and Fall semesters, 1971, a total of 133 students were enrolled in "S.P." Chemistry 2. Of these 133 students a total of 89 or 66.9% received a W grade.

Lecture Classes

Concerning the Spring, 1971, a total of 34 students were enrolled in both a "C.L." Chemistry 2 lecture and laboratory.

In the Fall, 1971, a total of 47 students were enrolled in both a Chemistry 2 "C.L." lecture and laboratory.

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* The use of the abbreviation W in this paper will denote withdrawal category grades (W & UW).

Combining the Spring and Fall semesters, 1971, a total of 81 students were enrolled in "C.L." Chemistry 2. Of these 81 students a total of 34 or 42.0% received a W grade. See Figure 1 for a graphic comparison of the "S.P." and "C.L." Chemistry 2 courses sampled.

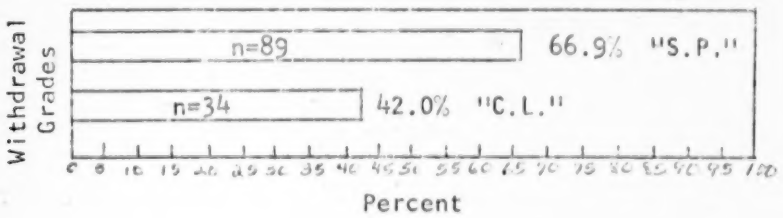

Fig. 1. Number and Percent of students who received "Withdrawal" grades: "S.P." and "C.L." Chemistry 2 courses. Spring and Fall, 1971.

Grade Distribution: "Self-Paced" and "Classical Lecture" Chemistry 2 courses.

Self-Paced Classes

Spring, 1971

Of the 53 students enrolled in both a Chemistry "S.P." lecture and laboratory:

0 or 0%	- - - -	received an A grade
11 or 20.7%	- - - -	received a B grade
6 or 11.3%	- - - -	received a C grade
0 or 0%	- - - -	received a D grade
0 or 0%	- - - -	received an F grade
5 or 9.4%	- - - -	received an E grade (incomplete)
31 or 58.4%	- - - -	received a W grade

Fall, 1971

Of the 80 students enrolled in both a Chemistry 2 "S.P." lecture and laboratory:

11 or 13.8%	- - - -	received an A grade
4 or 5.0%	- - - -	received a B grade
0 or 0%	- - - -	received a C grade
0 or 0%	- - - -	received a D grade
0 or 0%	- - - -	received an F grade
7 or 8.7%	- - - -	received an E grade
58 or 72.5%	- - - -	received a W grade

Lecture Classes

Spring, 1971

Of the 34 students enrolled in both a Chemistry 2 "C.L." lecture and laboratory:

1 or 2.9%	- - - -	received an A grade
4 or 11.8%	- - - -	received a B grade
8 or 23.5%	- - - -	received a C grade
4 or 11.8%	- - - -	received a D grade
3 or 8.8%	- - - -	received an F grade
0 or 0%	- - - -	received an E grade
14 or 41.2%	- - - -	received a W grade

Fall, 1971

Of the 47 students enrolled in both a Chemistry 2 "C.L." lecture and laboratory:

3 or 6.4%	- - - -	received an A grade
5 or 10.6%	- - - -	received a B grade
17 or 36.2%	- - - -	received a C grade
2 or 4.2%	- - - -	received a D grade
0 or 0%	- - - -	received an F grade
0 or 0%	- - - -	received an E grade
20 or 42.6%	- - - -	received a W grade

Comparing academic achievement (grades A through W) across "S.P." and "C.L." Chemistry 2 courses after combining Spring and Fall semesters, 1971, one finds that 11 or 8.3% of the 133 "S.P." students earned A's, compared to 4 or 4.9% of the 81 "C.L." students. Concerning the grade B it was earned by 15 or 11.3% of the "S.P." students, and by 9 or 11.1% of the "C.L." enrollees. Six (6) or 4.5% of the students earned C's, compared to 25 or 30.9% of the "C.L." students. Pertaining to D grades, none of the "S.P." students received a D compared to 6 or 7.4% of the "C.L." students. None of the "S.P." students received an F grade compared to 3 or 3.7% of the "C.L." students. Twelve (12) or 9.0% of the "S.P." students received an "Incomplete" (E) while none of the "C.L." students received an E. Concerning the grade of W, 89 or 66.9% of the 133 "S.P." students received a W, compared to 34 or 42.0% of the 81 "C.L." students. Figure 2 presents a graphic comparison of "academic achievement" across both the "S.P." and "C.L." classes sampled. Table 1 presents a statistical comparison of retention for the "S.P." and "C.L." Chemistry 2 students sampled*.

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* The Chi Square test for two independent groups was employed as a statistical test (.05 level of confidence).

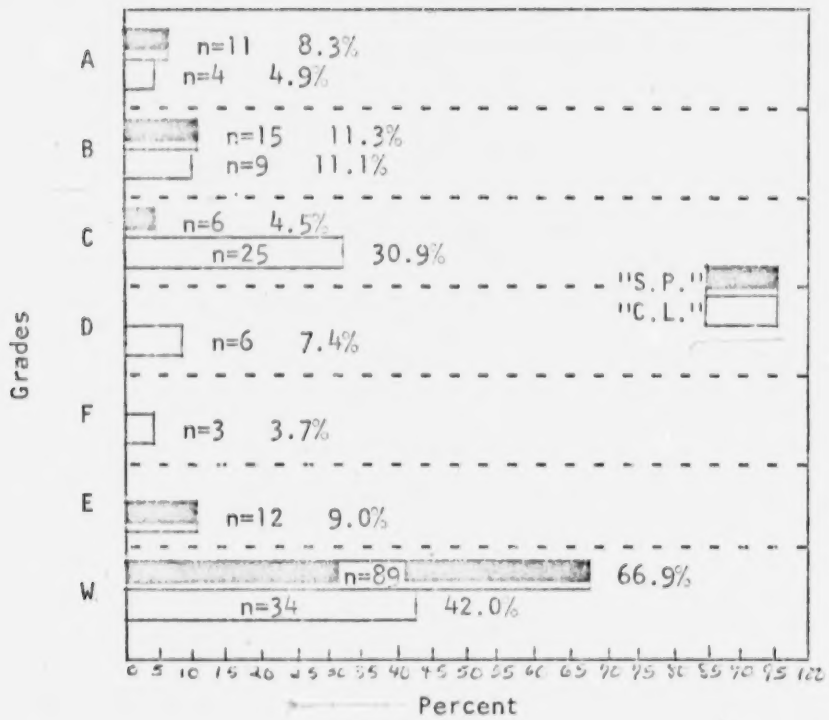

Fig. 2. Distribution of grades (A through W) for "Self-Paced" and "Classical Lecture" Chemistry 2 courses.

Table 1

Statistical Comparison of Retention
For the "S.P." and "C.L." Chemistry 2 Students Sampled

Student Groups	Withdrew	Remained	Sum
Self-Paced Chemistry 2	89	44	133
Classical Lecture Chemistry 2	34	47	81
Sum	123	91	214

Chi Square 11.81 sig. > .01 level.

If one operationally defines "successful" academic achievement as having earned a grade of A, B, or C and "unsuccessful" achievement as having earned a grade of D or F, then one observes that 32 or 24.1% of the 133 "S.P." students attained "successful" achievement while none attained "unsuccessful" achievement. Applying the same analysis to the "C.L." students one observes that 38 or 46.9% of the 81 "C.L." students attained "successful" achievement and 9 or 11.1% "unsuccessful" achievement. See Figure 3 for a graphic comparison and Table 2 for a statistical comparison*.

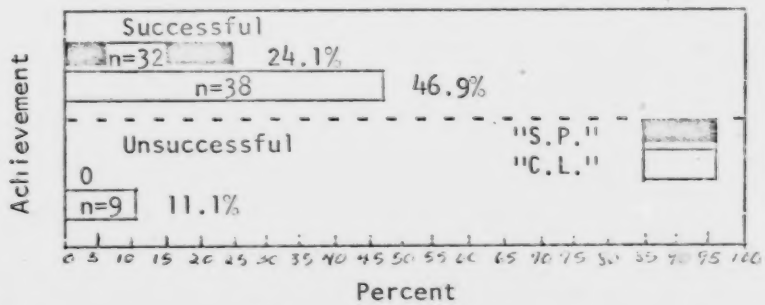

Fig. 3. Number and proportion of "S.P." and "C.L." Chemistry 2 students who attained "successful" or "unsuccessful" achievement. (Proportions based on total enrollment excluding "No Shows".)

* Fisher's Test of a difference between uncorrelated proportions was employed as a statistical test (.05 level of confidence).

Table 2

Comparison of Final Subject Grades (A through W) Between "S.P." And "C.L." Chemistry 2 Students as a Function of "Successful" Versus "Unsuccessful" Achievement. (Proportions based on total enrollment not including "No Shows".)

Final Grades	Group					
	"S.P."		"C.L."			
	No.	%	No.	%	Diff.	"t"
Successful Achievement	32	24.1%	38	46.9%	-22.8	3.21*
Unsuccessful Achievement	0	0	9	11.1%	-11.1	3.83*
Totals	32	24.1%	47	58.0%		

* Significant beyond the .05 level of confidence.

On the other hand, if the computation of "successful" and "unsuccessful" achievement is based on the total number of "S.P." or "C.L." students that earned a grade of A, B, C, D, or F, then one observes that 32 or 100% of the 32 "S.P." students attained "successful" achievement compared to 38 or 80.8% of the 47 "C.L." students. See Figure 4 for a graphic comparison and Table 3 for a statistical comparison.

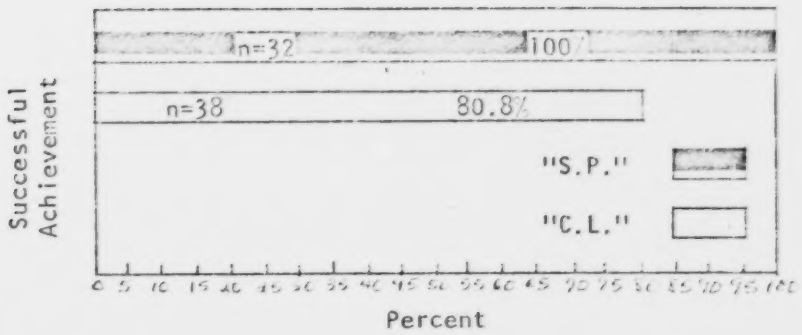

Fig. 4. Number and proportion of "S.P." and "C.L." Chemistry 2 students who attained "successful achievement. (Proportions based on total number of students who earned a grade of A through W.)

Table 3

Comparison of Final Subject Grades (A through W) Between "S.P." and "C.L." Chemistry 2 Students as a Function of "Successful" Versus "Unsuccessful" Achievement. (Proportions based on total number of students that earned a grade A through W.)

Final Grades	Group					
	"S.P."		"C.L."			
	No.	%	No.	%	Diff.	"t"
Successful Achievement	32	100.0%	38	80.8%	19.2	2.53*
Unsuccessful Achievement	0	0	9	19.2%	-19.2	2.63*
Totals	32	100.0%	47	100.0%		

* Significant beyond the .05 level of confidence.

Follow-Up Results: "Self-Paced"
And "Classical Lecture" Classes

"Self-Paced" Classes

Spring, 1971

Concerning the 53 students enrolled in both a Chemistry 2 "S.P." lecture and laboratory in the Spring, 1971, the follow-up study was carried out after the end of the Fall semester, 1971. Thus the Summer and Fall semesters 1971 were included in the follow-up study.

Of the 11 students who received a B in "S.P." Chemistry 2 in the Spring, 1971:

1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
3 or 27.3%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a D grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
4 or 36.3%	- - -	had not enrolled in a Chemistry course
1 or 9.1%	- - -	were no longer attending Cerritos College

Of the 6 students who received a C in "S.P." Chemistry 2 in the Spring, 1971:

1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade

1 or 16.7% - - - had subsequently enrolled in Chemistry 1.1 and received a W grade

2 or 33.3% - - - had not enrolled in a Chemistry course

2 or 33.3% - - - were no longer attending Cerritos College

Of the 5 students who received an E grade in "S.P." Chemistry 2 in the Spring, 1971:

1 or 20.0% - - - had subsequently enrolled in Chemistry 1.1 and received a C grade

2 or 40.0% - - - had not enrolled in a Chemistry course

2 or 40.0% - - - were no longer attending Cerritos College

Of the 31 students who received a W grade in "S.P." Chemistry 2 in the Spring, 1971:

11 or 35.5% had subsequently re-enrolled in a Chemistry 2 course. Of these 11 students:

2 or 18.2% - - received an A grade

1 or 9.1% - - received a B grade

1 or 9.1% - - received a C grade

1 or 9.1% - - received an E grade

6 or 54.5% - - received a W grade

Four (4) or 12.9% had enrolled in a Chemistry 10 course. Of these four students:

1 or 25.0% - - received a B grade

1 or 25.0% - - received an E grade

2 or 50.0% - - received a W grade

Six (6) or 19.4% had not enrolled in a Chemistry course.

Ten (10) or 32.2% were no longer attending Cerritos College.

Fall, 1971

Concerning the 80 students enrolled in both a Chemistry 2 "S.P." lecture and laboratory in the Fall, 1971, the follow-up study was carried out after the end of the Spring semester, 1972.

Of the 11 students who received an A in "S.P." Chemistry 2 in the Fall, 1971:

4 or 36.4%	- - -	had subsequently enrolled in Chemistry 1.1 and received an A grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a D grade
2 or 18.2%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
1 or 9.1%	- - -	had not enrolled in a Chemistry course
1 or 9.1%	- - -	were no longer attending Cerritos College

Of the 4 students who received a B in "S.P." Chemistry 2 in the Fall, 1971:

2 or 50.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
1 or 25.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 25.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade

NOTE: None of the "S.P." students enrolled in the Fall, 1971, received a D, E, or F grade.

Of the 7 students who received an E grade in "S.P." Chemistry 2 in the Fall, 1971:

2 or 28.6%	- - -	had subsequently enrolled in Chemistry 2 and received a W grade
1 or 14.3%	- - -	had subsequently enrolled in Chemistry 1.1 and received an E grade
3 or 42.8%	- - -	had not enrolled in a Chemistry course
1 or 14.3%	- - -	were no longer attending Cerritos College

Of the 58 students who received a W grade in "S.P." Chemistry 2 in the Fall, 1971:

29 or 50.0% had subsequently re-enrolled in a Chemistry 2 course. Of these 29 students:

1 or 3.4%	- -	received an A grade
5 or 17.2%	- -	received a B grade
1 or 3.4%	- -	received a C grade
1 or 3.4%	- -	received an F grade
21 or 72.4%	- -	received a W grade
20 or 34.5%	- -	had enrolled in a Chemistry course
9 or 15.5%	- -	were no longer attending Cerritos College

Spring & Fall, 1971, Combined

Combining the follow-up data for the 133 students enrolled in both a Chemistry 2 "S.P." lecture and laboratory one finds that of the 11 students who received an A:

4 or 36.4%	- - -	had subsequently enrolled in Chemistry 1.1 and received an A grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 9.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a D grade
2 or 18.2%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
1 or 9.1%	- - -	had not enrolled in a Chemistry course
1 or 9.1%	- - -	were no longer attending Cerritos College

Of the 15 students who received a B grade in "S.P." Chemistry 2:

3 or 20.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
4 or 26.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 6.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a D grade
2 or 13.3%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
4 or 26.7%	- - -	had not enrolled in a Chemistry course
1 or 6.7%	- - -	were no longer attending Cerritos College

Of the 6 students who received a C in "S.P." Chemistry 2:

1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
2 or 33.3%	- - -	were not enrolled in a Chemistry course
2 or 33.3%	- - -	were no longer attending Cerritos College

Of the 12 students who received an E in "S.P." Chemistry 2:

2 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
2 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
5 or 41.7%	- - -	were not enrolled in a Chemistry course
3 or 25.0%	- - -	were no longer attending Cerritos College

Of the 89 students who received a W grade in "S.P." Chemistry 2:

40 or 44.9% had subsequently re-enrolled in a Chemistry 2 course. Of these 40 students:

3 or 7.5%	- -	received an A grade
6 or 15.0%	- -	received a B grade
2 or 5.0%	- -	received a C grade
2 or 5.0%	- -	received an E grade
27 or 67.5%	- -	received a W grade

Four (4) or 4.5% had enrolled in a Chemistry 10 course. Of these 4 students:

1 or 25.0%	- -	received a B grade

1 or 25.0% - - received an E grade

2 or 50.0% - - received a W grade

26 or 29.2% - - had not enrolled in a Chemistry course

19 or 21.3% - - were no longer attending Cerritos College

Table 4 presents a summary of the follow-up results of the 133 students who were enrolled in both a Chemistry 2 Self-Paced lecture and laboratory (Spring and Fall, 1971). In addition, Table 5 presents a summary of the follow-up results concerning the 89 students who received a W grade in Self-Paced Chemistry 2.

Table 4

Follow-Up of the 133 students enrolled in both a Chemistry 2 Self-Paced lecture and laboratory (Spring & Fall, 1971)

Enrolled in Chem. 1.1	Grades Earned	Frequency	Percent	ACADEMIC ACHIEVEMENT	
25 or 18.9%	A	4	3.0%	Passed 18 or 72.0%	"Successful Achievement" 16 or 64.0%
	B	4	3.0%		
	C	8	6.0%		
	D	2	1.5%		"Unsuccessful Achievement"
	F	-	-	Did Not Pass 0 or 0%	2 or 8.0%
	E	-	-	Academic Achievement Unknown 0 or 0%	
	W	7	5.3%	Withdrew 7 or 28%	
Enrolled in Chemistry 10		4	3.0%	-	-
Re-enrolled in Chemistry 2		40	30.0%	-	-
Not Enrolled in a Chemistry course		38	28.6%	-	-
Not Enrolled at Cerritos College		26	19.6%	-	-

* Proportions concerning academic achievement based on total number of students receiving a grade A through W.

Table 5

Follow-Up of the 89 students who received a W grade in Self-Paced Chemistry 2

Re-Enrolled in Chem. 2	Grades Earned	Frequency	Percent	ACADEMIC ACHIEVEMENT	
40 or 44.9%	A	3	3.4%	Passed 11 or 27.5%	"Successful Achievement"* 11 or 27.5%
	B	6	6.7%		
	C	2	2.3%		
	D	-	-		"Unsuccessful Achievement"
	F	-	-	Did Not Pass 0 or 0%	0 or 0%
	E	2	2.3%	Academic Achievement Unknown	2 or 5.0%
	W	27	30.3%	Withdrew	27 or 67.5%
Enrolled in Chemistry 10		4	4.5%	-	-
Not Enrolled in a Chemistry course		26	29.2%	-	-
Not Enrolled at Cerritos College		19	21.4%	-	-

* Proportions concerning academic achievement based on total number of students receiving a grade A through W.

"Classical Lecture" Classes

Spring, 1971

The follow-up study of the 34 students enrolled in both a Chemistry 2 "C.L." lecture and laboratory in the Spring, 1971, was carried out after the end of the Fall semester, 1971. Thus, like the "S.P." classes, the Summer and Fall semesters, 1971, were included in the follow-up study.

As of the Fall semester, 1971, the one student who received an A in "C.L." Chemistry 2 in the Spring was no longer enrolled at Cerritos College.

Of the 4 students who received a B in "C.L." Chemistry 2 in the Spring, 1971:

1 or 25.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 25.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
2 or 50.0%	- - -	were no longer enrolled at Cerritos College

Of the 8 students who received a C in "C.L." Chemistry 2 in the Spring, 1971:

2 or 25.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
4 or 50.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 12.5%	- - -	had not enrolled in a Chemistry course
1 or 12.5%	- - -	were no longer attending Cerritos College

Of the 4 students who received a D in "C.L." Chemistry 2 in the Spring, 1971:

1 or 25.0%	- - -	had subsequently re-enrolled in Chemistry 2 and received a B grade
1 or 25.0%	- - -	had subsequently re-enrolled in Chemistry 2 and received a C grade
1 or 25.0%	- - -	had subsequently re-enrolled in Chemistry 2 and received a W grade
1 or 25.0%	- - -	were no longer attending Cerritos College

Of the 3 students who received an F in "C.L." Chemistry 2 in the Spring, 1971:

1 or 33.3%	- - -	had re-enrolled in Chemistry 2 and received an E grade
1 or 33.3%	- - -	had re-enrolled in Chemistry 2 and received a W grade
1 or 33.3%	- - -	were no longer enrolled at Cerritos College

Of the 14 students who received a W in "C.L." Chemistry 2 in the Spring, 1971:

Three (3) or 21.4% had subsequently re-enrolled in a Chemistry 2 course. Of these 3 students:

1 or 7.1%	- -	received an E grade
2 or 14.3%	- -	received a W grade

6 or 42.8%	- - -	had not enrolled in a Chemistry course
5 or 35.7%	- - -	were no longer attending Cerritos College

Fall, 1971

Concerning the 47 students enrolled in both a Chemistry 2 "C.L." lecture and laboratory in the Fall, 1971, the follow-up study was carried out after the end of the Spring semester, 1972.

Of the 3 students who received an A in "C.L." Chemistry 2 in the Fall, 1971:

1 or 33.3%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
2 or 66.7%	- - -	had not enrolled in a Chemistry course

Of the 5 students who received a B in "C.L." Chemistry 2 in the Fall, 1971:

1 or 20.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received an A grade
3 or 60.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 20.0%	- - -	had not enrolled in a Chemistry course

Of the 17 students who received a C in "C.L." Chemistry 2 in the Fall, 1971:

3 or 17.6%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
9 or 52.9%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
4 or 23.5%	- - -	had not enrolled in a Chemistry course
1 or 5.9%	- - -	were no longer attending Cerritos College

Of the 2 students who received a D in "C.L." Chemistry 2 in the Fall, 1971:

2 or 100.0% - - - had not enrolled in a Chemistry course

Of the 20 students who received a W grade in "C.L." Chemistry 2 in the Fall, 1971:

Four (4) or 20.0% had re-enrolled in Chemistry 2. Of these 4 students:

1 or 5.0% - - received a C grade

3 or 15.0% - - received a W grade

12 or 60.0% - - - had not enrolled in a Chemistry course

4 or 20.0% - - - were no longer attending Cerritos College

Spring & Fall, 1971, Combined

Combining the follow-up data for the 81 students enrolled in both a Chemistry 2 "C.L." lecture and laboratory one finds that of the 4 students who received an A:

1 or 25.0% - - - had subsequently enrolled in Chemistry 1.1 and received a C grade

2 or 50.0% - - - had not enrolled in a Chemistry course

1 or 25.0% - - - were no longer attending Cerritos College

Of the 9 students who received a B in "C.L." Chemistry 2:

1 or 11.1% - - - had subsequently enrolled in Chemistry 1.1 and received an A grade

4 or 44.4% - - - had subsequently enrolled in Chemistry 1.1 and received a C grade

1 or 11.1%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
1 or 11.1%	- - -	had not enrolled in a Chemistry course
2 or 22.2%	- - -	were no longer attending Cerritos College

Of the 25 students who received a C in "C.L." Chemistry 2:

5 or 20.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
13 or 52.0%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
5 or 20.0%	- - -	had not enrolled in a Chemistry course
2 or 8.0%	- - -	were no longer attending Cerritos College

Of the 6 students who received a D in "C.L." Chemistry 2:

1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a B grade
1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a C grade
1 or 16.7%	- - -	had subsequently enrolled in Chemistry 1.1 and received a W grade
2 or 33.3%	- - -	had not enrolled in a Chemistry course
1 or 16.7%	- - -	were no longer attending Cerritos College

Of the 3 students who received an F in "Classical Lecture" Chemistry 2:

1 or 33.3%	- - -	had re-enrolled in Chemistry 2 and received an E grade

1 or 33.3% - - - had re-enrolled in Chemistry 2 and received a W grade

1 or 33.3% - - - was no longer enrolled at Cerritos College

Of the 34 students who received a W in "C.L." Chemistry 2:

Seven (7) or 20.6% re-enrolled in Chemistry 2. Of these 7 students:

1 or 14.3% - - received a C grade

1 or 14.3% - - received an E grade

5 or 71.4% - - received a W grade

18 or 52.9% - - - had not enrolled in a Chemistry course

9 or 26.5% - - - were no longer attending Cerritos College

Table 6 presents a summary of the follow-up results concerning the 81 students enrolled in both a Chemistry 2 Classical lecture and laboratory (Spring and Fall, 1971). Table 7 presents a summary of the follow-up results concerning the 34 students who received a W grade in classical lecture Chemistry 2. Table 8 presents a statistical comparison concerning enrollment in Chemistry 1.1

Table 6

Follow-Up of the 81 students enrolled in both a Chemistry 2 Classical lecture and laboratory (Spring & Fall, 1971)

Enrolled in Chem. 1.1	Grades Earned	Frequency	Percent	ACADEMIC ACHIEVEMENT	
29 or 35.8%	A	1	1.2%	Passed 13 or 44.8%	"Successful Achievement"* 13 or 44.8%
	B	1	1.2%		
	C	11	13.6%		
	D	-	-		"Unsuccessful Achievement"
	F	-	-	Did Not Pass 0 or 0%	0 or 0%
	E	1	1.2%	Academic Achievement Unknown	1 or 3.5%
	W	15	18.5%	Withdrew	15 or 51.7%
Enrolled in Chemistry 10		-	-	-	-
Re-enrolled in Chemistry 2		8	9.9%	-	-
Not Enrolled in a Chemistry course		28	34.6%	-	-
Not Enrolled at Cerritos College		16	19.8%	-	-

* Proportions concerning academic achievement based on total number of students receiving a grade A through W.

Table 7

Follow-Up of the 34 students who received a W Grade in Classical lecture Chemistry 2

Re-Enrolled in Chem. 2	Grades Earned	Frequency	Percent	ACADEMIC ACHIEVEMENT
7 or 20.6%	A	-	-	Passed 1 or 14.3% "Successful Achievement"* 1 or 14.3%
	B	-	-	
	C	1	2.9%	
	D	-	-	"Unsuccessful Achievement"
	F	-	-	Did Not Pass 0 or 0% — 0 or 0%
	E	1	2.9%	Academic Achievement Unknown 1 or 14.3%
	W	5	14.7%	Withdrew 5 or 71.4%
Enrolled in Chemistry 10		-	-	- -
Not Enrolled in a Chemistry course		18	52.9%	- -
Not Enrolled at Cerritos College		9	26.5%	- -

* Proportions concerning academic achievement based on total number of students receiving a grade A through W.

Table 8

A Comparison Between "S.P." and "C.L." Chemistry 2 Students as a Function of Enrollment and Academic Achievement in Chemistry 1.1

Academic Status	Group "S.P." Chem. 2 %	"C.L." Chem. 2 %	Diff.	"t"
Enrolled in Chemistry 1.1	18.9%	35.8%	-16.9%	2.75*
Passed Chemistry 1.1	72.0%	44.8%	27.2%	1.98
"Successful" Academic Achievement	64.0%	44.8%	19.2%	1.39

* Significant beyond the .05 level of confidence.

Summary of Retention

Comparing retention in "S.P." and "C.L." Chemistry 2 it was found that 89 or 66.9% of the 133 "S.P." students withdrew, compared to 34 or 42.0% of the "C.L." students. Of the 89 "S.P." withdrawals 40 or 44.9% re-enrolled in Chemistry 2 compared to 7 or 20.6% of the 34 "C.L." withdrawals. Furthermore, of the 40 "S.P." withdrawals who re-enrolled in Chemistry 2, 27 or 67.5% again withdrew compared to 5 or 71.4% of the 7 "C.L." re-enrollees.

Thus after two semester attempts, the net withdrawal rate for the "S.P." Chemistry 2 and 77 or 57.9% compared to 32 or 39.5% for "C.L." Chemistry 2. See Table 9 and 10.

Table 9

Summary of Retention

	Self-Paced	Classical Lecture
Enrollment	133	81
*		
Withdrawals	89 or 66.9%	34 or 42.0%
*		
Withdrawals Re-Enrolled in Chemistry 2	40 or 44.9% of the original 89	7 or 20.6% of the original 34
*		
Second-Time-Around Withdrawals	27 or 67.5% of the 40 re-enrollees	5 or 71.4% of the 7 re-enrollees
*		
Net Withdrawal Rate	77 or 57.9% of the total enrollment	32 or 39.5% of the total enrollment

Table 10

A Comparison Between "S.P." and "C.L." Chemistry 2 Students Concerning Retention

Retention	Group "S.P." Chem. 2 %	"C.L." Chem. 2 %	Diff.	"t"
Withdrawals Re-Enrolled in Chemistry 2	44.9%	20.6%	24.3	9.68*
Second-Time-Around Withdrawals	67.5%	71.4%	-3.9	0.20
Net Withdrawal Rate	57.9%	39.5%	18.4	2.59*

* Significant beyond the .05 level of confidence.

Summary of Findings

1. Under the "Self-Paced" approach to the study of Elementary Chemistry (Chemistry 2) the withdrawal rate was significantly* greater compared to the "Classical Lecture" approach.

2. Significantly more of the "C.L." students attained successful achievement in Elementary Chemistry compared with the "S.P." students (proportions based on total enrollment).

3. If the computation of successful achievement is based on the total number of "S.P." or "C.L." students that earned a grade of A, B, C, D, or F then the proportion of "S.P." students who attained successful academic achievement is significantly greater than that of the "C.L." students.

4. A significantly greater proportion of "C.L." Chemistry 2 students enrolled in General Chemistry compared to the "S.P." students.

5. A greater proportion of "S.P." students passed General Chemistry compared to the "C.L." students.

6. A greater proportion of "S.P." students attained successful achievement in General Chemistry.

7. A significantly greater proportion of "S.P." Chemistry 2 withdrawals re-enrolled in Chemistry 2 than did the "C.L." withdrawals.

8. The "net withdrawal rate" for the "S.P." students was significantly greater than that of the "C.L." students.

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* The word "significantly" denotes that the percentage difference in the comparison was statistically significant at or beyond the .05 level of confidence.

APPENDIX A

APPENDIX A**

Table 1

Follow-Up of the Eleven "S.P." Re-enrollees Who Passed Elementary Chemistry the Second Time Around

Enrolled in Chem. 1,1	Grades Earned	Frequency	Percent	ACADEMIC ACHIEVEMENT	
8 or 72.7%	A	1	9.0%	Passed 4 or 50.0%	"Successful Achievement"* 4 or 50%
	B	-	-		
	C	3	27.3%		
	D	-	-		"Unsuccessful Achievement"
	F	-	-	Did Not Pass 0 or 0%	0 or 0%
	E	-	-	Academic Achievement Unknown	0 or 0%
	W	4	36.4%	Withdrew	4 or 50%
Not Enrolled in a Chemistry course		3	27.3%	-	-

* Proportions concerning academic achievement based on total number of students receiving a grade A through W.

** This follow-up was requested after the results of the study were presented to the members of the Chemistry Department.

The follow-up of the one "C.L." re-enrollee who passed Elementary Chemistry the second-time around revealed that they had subsequently not enrolled in a Chemistry course.